CLAIMS

1. A two-stage plasma process for converting waste having organic and inorganic components into fuel gas, which comprises:

(a) in the first stage, vitrifying or melting the inorganic components of the waste and partially gasifying the organic components; and

(b) in the second stage, completing the gasification of the organic components so as to convert them into fuel gas.

2. A process according to claim 1, in which a dust separation and removal step is provided between the two stages of the process.

3. A process according to claims 1 or 2, in which the fuel gas produced in the second stage is quenched and cleaned to make it suitable for use in a gas engine or turbine for production of electricity or in a gas burner for production of steam or in chemical synthesis reactions.

4. A process according to claims 1, 2 or 3, in which the first stage is carried out in a plasma arc furnace.

5. A process according to any one of claims 1 to 4, in which the second stage is carried out in a secondary gasifier using a plasma torch with addition of metered amounts of oxygen, air and/or steam.

6. A process according to claim 4, in which the plasma arc furnace is a refractory lined, enclosed furnace provided with at least one direct current graphite electrode adapted to generate a plasma arc to a bath of liquid inorganic material originating from the waste itself and located at the bottom of the furnace.

7. A process according to claim 6, in which said liquid inorganic material comprises a slag layer which is maintained at a temperature of at least 1500°C.

8. A process according to claim 7, in which said liquid inorganic material further comprises a metal layer also maintained at a temperature of at least 1500°C and located under the slag layer.

9. A process according to claims 6, 7 or 8, in which the waste is introduced into the furnace on top of the liquid inorganic material and the organic component in the waste reacts with air, oxygen and/or steam supplied to the furnace in a predetermined amount adapted to achieve gasification of organic material in the waste into a primary synthesis gas containing CO, H_2, CO_2 and N_2 if the waste contains nitrogen or if air is added to the furnace, and also containing some soot and complex organic molecules.

10. A process according to claim 9, in which the organic material in the waste is so reacted as to form a layer of partially treated waste on top of the slag layer and fresh waste is introduced into the furnace on top of said partially treated waste layer which is maintained at a temperature of between 700 and 800°C and constitutes a cold top for the fresh waste added to the furnace.

11. A process according to claims 9 or 10, in which the primary synthesis gas is subjected to dust separation and removal in which dust particles larger than a predetermined size are separated and removed.

12. A process according to claim 11, in which the removed dust particles are recycled to the furnace.

13. A process according to claim 5, in which the secondary gasifier is equipped with a plasma torch fired eductor which ensures that gas from the first stage of the process entering the secondary gasifier is exposed to a high temperature such as to transform essentially all soot present in the gas to CO and to convert essentially all complex organic molecules to simpler molecules CO, CO_2 and H_2.

14. A process according to claim 13, in which the high temperature to which gas from the first stage is exposed in the secondary gasifier is between 900°C and 1300°C.

15. A process according to claim 14, in which the high temperature is achieved mainly by partial oxidation of the gas from the first stage by injection of predetermined amounts of air, oxygen and/or steam to the eductor, and the plasma torch provides only a small fraction of the energy required for maintaining said high temperature.

16. A process according to claims 13, 14 or 15, in which the fuel gas exiting the secondary gasifier is cooled down very rapidly to a temperature below 100°C so as to freeze the thermodynamic equilibrium of the fuel gas and avoid production of secondary pollutants.

17. A process according to claim 16, in which after cooling, the fuel gas is subjected to a final cleaning operation to remove any remaining contaminants.

18. A process according to any one of the preceding claims 1 to 16, in which the process is carried out under a negative pressure to preclude exit of toxic fumes or of flammable materials from any unit operations.

19. A process according to any one of the preceding claims 1 to 18, in which an oxygen starved environment in used in the process to preclude dioxin formation.

20. Apparatus for converting waste having organic and inorganic components into fuel gas, which includes;

(a) a primary gasifier comprising a refractory lined, enclosed plasma arc furnace provided with at least one graphite electrode; at least one inlet for feeding waste into the furnace; means for feeding air, oxygen

and/or steam in metered amounts into the furnace; and a gas take off port for primary synthesis gas produced in said primary gasifier; said primary gasifier being adapted to maintain layers of molten metal and molten slag at the bottom of the furnace and on top of the molten slag a layer of partially treated waste on top of which fresh waste is fed; and said at least one graphite electrode is positioned so as to generate a plasma arc to the molten slag present in the furnace during the operation; and

(b) a secondary gasifier to which the primary synthesis gas is fed, said secondary gasifier being equipped with a plasma-torch fired eductor which ensures that the primary synthesis gas entering from the primary gasifier is exposed to a high temperature such as to transform any soot present in said primary gas into CO and to convert any complex organic molecule to simpler molecules CO, CO_2 and H_2; means for supplying metered amounts of air, oxygen and/or steam into the eductor; said eductor leading to an insulated chamber with a minimal heat loss; and an outlet being provided in said chamber for the fuel gas resulting from the operation.

21. Apparatus according to claim 20, in which in the primary gasifier two graphite electrodes are used creating an arc between one electrode and the slag during the operation, and creating a second arc from the slag to the second electrode.

22. Apparatus according to claims 20 or 21, in which the eductor provided in the secondary gasifier is made of a high heat metal alloy or is refractory lined or water cooled, and is equipped with the plasma torch at its inlet.

23. Apparatus according to claims 20, 21 or 22, further comprising a dust separator between the primary gasifier and the secondary gasifier.

24. Apparatus according to any one of claims 20 to 23, further comprising a gas quenching and gas cleaning means following the secondary gasifier.

25. Apparatus according to any one of claims 20 to 24, further comprising an induced draft fan adapted to operate the apparatus under a negative pressure.